

# CONTEMPORARY MATHEMATICS

531

## Combinatorics and Graphs

Twentieth Anniversary Conference of IPM  
Combinatorics  
May 15–21, 2009  
Tehran, Iran

Richard A. Brualdi  
Samad Hedayat  
Hadi Kharaghani  
Gholamreza B. Khosrovshahi  
Shahriar Shahriari  
Editors



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Participants in the IPM 20 - Combinatorics 2009 Conference

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## Preface

IPM, the Institute for Research in Fundamental Sciences in Tehran, Iran, commemorated the 20th anniversary of its founding by a major international conference IPM 20 - Combinatorics 2009 on May 15-21, 2009. The conference was dedicated to Reza Khosrovshahi, one of the founders of IPM and the director of its School of Mathematics from 1996 to 2007, on the occasion of his 70th birthday. This volume contains a collection of some of the papers presented at the conference.

Mathematics has a long history in the Iranian plateau. Between the ninth and the fifteenth centuries, Iranian mathematicians played a central role in the development of mathematics in the Islamic world. Mathematicians such as Khawrizmi, Mahani, Nayrizi, Buzjani, Quhi, Karaji, Biruni, Khayyam, Tusi, and Kashani hailed—as their names suggest—from all corners of the Iranian world, and over a seven hundred period transformed the mathematical heritage inherited from India, Persia, and most notably Greek Alexandria. Algebra—whose name comes from Khawrizmi’s first book on the subject— was developed and eventually became a discipline distinct from Geometry with its own problems and methods. The concept of number was enlarged to include Euclid’s magnitudes, and, by the time of Kashani in the fifteenth century, real numbers and their decimal expansions were used easily and productively. With applications to astronomy and geography in mind, trigonometry and spherical geometry were systematized and developed. Binomial coefficients and their properties (including the so-called “Pascal’s triangle”) were developed and used extensively. In this period, applied mathematics also blossomed. Mathematicians working in collaboration with artisans, architects, and astronomers developed many practical algorithms (in fact, the word algorithm comes from the name of Khawrizmi) and approximation procedures.

Nevertheless, after the fifteenth century, there was a marked decline in original mathematical activity in Iran. While the study of Euclid and the classics of Islamic mathematics continued unabated, mathematics lost the center stage. Fast forwarding to the most recent period, Iranian mathematics started its reawakening in the years following World War II when mathematicians centered around University of Tehran, most notably Dr. Gholamhossein Mosahab, trained a generation of mathematics educators. In turn, in the 1960s and 70s, a dedicated group of legendary high school level math teachers disseminated a love for mathematics among the youth. This was the period when mathematical problem solving and mathematical books for non-experts became popular and when a number of high school mathematics teachers developed a national reputation. The next big step in the development of mathematics in Iran came in 1989 with the founding of IPM (Institute for Studies in Theoretical Physics and Mathematics since renamed the Institute for Research in Fundamental Sciences). This was complemented by the



establishment of doctoral programs in mathematics in the leading universities of the country. The devastating eight year Iran-Iraq war had just ended, and Iran had begun the process of reconstruction. It is not unusual in such situations to focus on immediate needs and to forego basic research in mathematics and science. However, a group of far-sighted Iranian mathematicians and physicists (including Reza Khosrovshahi) were able to convince the authorities to devote resources to a center for research in mathematics and theoretical physics. From the beginning the center focused on original publishable research and on mentoring and supporting young researchers. In a short span of twenty years, the center became the premier research center in the country and developed an international reputation.

Currently, the Institute for Research in Fundamental Sciences (IPM) includes eight schools: Mathematics, Physics, Cognitive Sciences, Computer Sciences, Nano-Sciences, Analytic Philosophy, Astronomy, and Particles and Accelerators. The School of Mathematics of IPM has three research emphases: Combinatorics and Computing, Commutative Algebra, and Mathematical Logic. As a part of its activities, IPM's cluster group in combinatorics, headed by Reza Khosrovshahi, has organized several well attended and successful international conferences in various areas of combinatorics. IPM 20-Combinatorics 2009 was the latest of these conferences.

The organizing committee for the conference consisted of S. Akbari, R.A. Brualdi, S. Hedayat, H. Kharaghani, G.B. Khoshrovshahi (chair), R. Maimani, S. Shahriari, and B. Tayfeh-Rezaie. The invited speakers were: Eiichi Bannai (Kyushu University, Japan), Helene Barcelo (Mathematical Sciences Research Institute, USA), Andries Brouwer (Eindhoven University of Technology, Netherlands), Richard A. Brualdi (University of Wisconsin-Madison, USA), Peter Frankl (Waseda University, Japan), Willem H. Haemers (Tilburg University, Netherlands), Samad Hedayat (University of Illinois, Chicago, USA), Gyula O.H. Katona (Alfred Renyi Institute of Mathematics, Hungary), Hadi Kharaghani (University of Lethbridge, Canada), Jack Koolen (Pohang University of Science and Technology, South Korea), William J. Martin (Worcester Polytechnic Institute, USA), Brendan McKay (Australian National University, Australia), Shahriar Shahriari (Pomona College, USA), Jozef Širáň (Slovak University of Technology, Slovak Republic), Richard P. Stanley (Massachusetts Institute of Technology, USA), Robin Thomas (Georgia Institute of Technology, USA), Qiang (Steven) Wang (Carleton University, Canada), Richard M. Wilson (California Institute of Technology, USA), and Qing Xiang (University of Delaware, USA). There were over 200 people registered for the conference generating a lot of discussion and excitement before and after talks. Iranian mathematicians were very eager to learn and discuss mathematics with their international guests, and the international guests learned of recent activity in combinatorics by Iranians. As with previous IPM conferences the international guests were treated with great warmth, hospitality, and generosity, and the organization was impeccable. Outside of the talks, the conference dinner was a magnificent affair, there were excursions to the Carpet Museum and the Saadabad Palace in Tehran, as well as an overnight trip to the city of Esfahan.

We are indebted to the Editorial Committee of the American Mathematical Society for agreeing to publish these refereed proceedings in their Contemporary Mathematics series.

Richard A. Brualdi  
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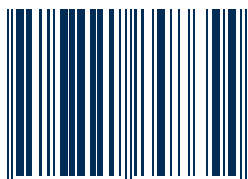
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The conference celebrated IPM's 20th anniversary and was dedicated to Reza Khosrovshahi, one of the founders of IPM and the director of its School of Mathematics from 1996 to 2007, on the occasion of his 70th birthday.

The conference attracted an international group of distinguished researchers from many different parts of combinatorics and graph theory, including permutations, designs, graph minors, graph coloring, graph eigenvalues, distance regular graphs and association schemes, hypergraphs, and arrangements.

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